

XX. *On the Duration of Life in the Queen, Drone and Worker of the Honey Bee; to which are added Observations on the Practical Importance of this Knowledge in deciding whether to preserve Stocks or Swarms: being the Prize Essay of the Entomological Society of London for 1852. By J. G. DESBOROUGH, Esq.*

“ In tenui labor at tenuis non gloria.”

FOR ages past the bee has many times occupied the attention of the naturalist, and numerous works have appeared under various titles, some treating of the management of the honey bee alone, and others of its management, as well as natural history; yet it is somewhat remarkable that none of them have treated on “The duration of life in the honey bee;” and although in some of the *bee books* an occasional sentence touching the age of bees may be observed, no connected or definite information or argument on that portion of the subject is to be found.

The poet Virgil in his fourth Georgic, alluding to this subject, says, “*Neque enim plus septima ducitur æstas*,” but it is not very clear whether he alludes to the age of the bee individually, or to the duration of life in a stock of bees. “*Stat fortuna domus*,” would incline us to think that the stock was here spoken of, and not the single bee.

A degree of mystery likewise pervades the volumes of the early writers on bees, and even at the present day “*bee superstitions*” are prevalent in all parts of the kingdom, and their influence is so powerful, that any attempt to alter the system of bee management practised by the forefathers of the cottage beekeepers, is looked upon with a suspicion scarcely to be credited unless experienced.

The system usually adopted by cottagers in keeping their bees affords but little scope for observation; indeed the only observations which can possibly be made under such a system are the external appearances of the hives or stocks; the queen is never seen, the combs containing the brood cannot in anyway be inspected, and even after the murderous hand of their master has deprived the stock of its existence, the bees are unceremoniously buried without notice; we cannot, therefore, expect much assist-

ance from such a system to aid us in our present research, but still an occasional inference may be drawn from the little that may be thence gathered, as will hereafter be seen.

When, however, bee keeping is treated as a science, and the beekeeper's study is to adopt every expedient to secure the comfort and well-doing of his bees,—when his hives are constructed in such a mode, that daily and hourly observations may be made on the proceedings of his bees,—when he can proudly say, by care and management he has preserved his stocks in health and prosperity for years, instead of killing them ruthlessly in the first season of their existence,—any steps tending to assist him in so laudable an object, or to encourage him to persevere, deserve to be hailed with delight; even on the score of profit it might be easily shown that the old system of taking honey by killing the bees ought at once to be abolished, but such a course of argument would be foreign to the present essay.

Apart from any consideration on the ground of bee management, the hives in use under a scientific mode are much more adapted for observation of all kinds, and therefore it will be to them we must look for help in treating our present subject; and when a record of observations has been kept, and a series of comparatively unimportant notes are brought into one focus, the information contained therein will assume so different a shape, that even the observer himself will scarcely be persuaded that his conclusions are faithfully drawn, so valueless did the notes appear in their crude state.

The writer of this essay has kept a series of memoranda as to the proceedings of the stocks of bees in his apiary, more particularly as to their swarming, since the year 1839; and although such notes were originally commenced as an amusement, it was soon perceived that for practical purposes they were of great importance: a careful digest of such memoranda, in the nature somewhat of a pedigree of his stocks, is the groundwork of this essay.

It will hardly be necessary after the above remarks to add that he has pursued the humane system of bee management, that his hives are therefore constructed so as to afford sufficient means of observation; but a short digression from the subject for the purpose of saying a few words on a hive, which may truly be called "An Observatory Hive," may not be deemed out of place. This hive is so constructed that each cell is distinctly visible to the bottom. The hive is in its principle unicomb; at the same time, by

a peculiar arrangement of the combs, the bees are not so widely distributed as in the ordinary uncomb hive. Both sides of every comb can at any moment be inspected, and this without the least interruption to the labours of the bees; the queen can at all times be found, and the laying of eggs by her has been so frequently seen, that it has ceased to be a matter of curiosity (he will not say of interest) to the writer. The difficulty heretofore has been to keep the stock in this hive alive during the winter, and this has not yet been attained (three trials having proved unsuccessful); but this season the hive, instead of being in an apiary, has been established in one of the rooms of the writer's dwelling-house,—in fact his bedroom; and at this period (December) he has the satisfaction of seeing the stock in perfect health and strength, and has every prospect, by the means he is adopting, of overcoming the difficulty before experienced of keeping the bees with which the hive is stocked alive, and thus actual daily observation can be made throughout the winter.

After these few introductory remarks, and the above short sketch of the means we possess for observation, we proceed at once to the consideration of the subject of the essay.

AGE OF THE QUEEN.

From the very peculiar habits of the queen bee, differing in all respects from the other inhabitants of the hive, in her constantly abiding within the hive or stock of which she is solely the monarch, and from the difficulty and almost total impracticability of any attempt to identify her by marking or mutilation of any kind, nothing short of the closest observation during a number of years, a diligent noting of facts, and a careful and unprejudiced examination of the whole, will enable an apiarian to venture an opinion, much less to form a conclusion, as to the duration of life in this insect.

That the queen bee exists for a longer period than one year is easily to be shown, but for how much longer is a question not so readily answered. Trace the existence of a queen; and for this purpose select a stock of bees which has already thrown off its swarm led by the old queen, and also its cast led by a young queen; the stock will then be left to the government of one young queen, which was in embryo at the departure of the swarm (all the other young queens we will presume to have been killed with the exception of the one selected to reign); this young queen was of course produced from an egg laid at some period of the summer,* say of the year 1849, and for sake of identity we will

* Proved by my observatory hive, see note in p. 149.

call this stock A. The same season, 1849, our young queen commences her work of laying eggs, thereby recruiting the population of the hive, now so greatly reduced by the departure of the swarm and cast; and as the eggs she produces at this period are all workers, the numerical strength of the hive is so far re-established as to enable it to brave the dangers of the winter season. The next year, 1850, our young queen of the previous year may be styled an old queen, her progeny in hive A has increased the population of the hive so much as to render a swarm necessary to be thrown off, and the swarm of 1850, which we call B, is led by the queen of the year 1849. The same proceeding occurs with our swarm of 1850, and the same necessity is occasioned in the year 1851; and the swarm issuing in that year, which we will call C, is again led by our queen of 1849: this would go on ad infinitum were not the insect tribe under the same sentence as man and all things on the face of nature, "once born and once to die." When that death takes place in the queen bee is our important question.

We have traced a queen from the summer of 1849 to the summer of 1851, and the proof that the same queen has existed for these three years is this, that the stock of 1849 threw off a swarm in 1850, and from the swarm of 1850 a swarm issued in 1851; and as swarms are led by an old queen, both the swarms of 1850 and 1851 are led by the same queen, being the one produced in the year 1849, under the circumstances with which we started the history of our selected queen. That it is the same queen is proved by the fact that all the young queens would be left in the hives A and B at the time of the issuing of the swarms therefrom; and as the swarm issued from hive A in the first summer after the birth of our selected queen, and from hive B in the first year of its existence after being hived as a swarm, it must be apparent (unless the fact of the swarm being led by an old queen is disputed) that these swarms, respectively identified by the letters B and C, were led by the queen brought forth in the year 1849 from the hive A; but had the stocks marked A and B omitted to send forth a swarm at the times we have stated, then it would not be the fact that the swarms issuing from hive A and B were led by the same queen, as we shall presently endeavour to show.

Now the swarm of 1851 (C), although living in the year 1852, does not in that year send forth a swarm; still the stock lives and flourishes, the bees are numerous, and apparently the population

is strong enough to follow the usual order of nature; the multiplication and the preservation of the species by the natural division of swarming has not this year taken place. Why has this instinct in the bee, at other times so strong, been disregarded? Why has the natural economy of the hive been disturbed? What is the solution of this paradox?—the natural death and the renewal of the queen. Age and decay have done their work, the natural powers of the insect have become exhausted, and she has quietly and peacefully departed, leaving her subjects to mourn her loss for a short space of time only, for she has left behind her an offspring of the royal stock, a successor to the throne is in embryo, and all this taking place whilst numbers of drones are in the hive produced from eggs laid by the late queen; no fear need be entertained of the impregnation of the new queen in order to ensure the future existence of the stock. The young queen accordingly comes forth, is impregnated, and carries forward the necessary routine of the hive. This young queen, like her predecessor, begins to lay eggs within five days of her coming to maturity,* and at the end of a further period of twenty-one days worker bees are again added to the population of the hive and all is again well; in fact the hive is now precisely in the same state as the hive with which we commenced our proposition, with this exception, that in the first case the old queen had been disposed of by departing with the swarm, and in the present case she has paid the debt of nature—death.

But what proof have we of this state of things taking place from the outward appearances of the hive and the proceedings of the bees themselves? We have this: towards the end of the month of May, or the beginning of the month of June, we may often observe a large quantity of bees hanging on the outside of the hive, sometimes extending a considerable way underneath the alighting board, or in any place where a convenient hold can be obtained, apparently listless and idle; no work is going on, although honey might be obtained in abundance were the bees inclined to work, and even if the weather should be what the most anxious apiarian could desire the bees still remain in this extraordinary state. Although stimulated in other years to seek another abiding place for the over abundant population of the hive by swarming, this year they seem to have no desire or intention to do so; their natural instinct seems to be blunted; in a word, the

* 1852 July 16 Stocked observatory hive with a cast.
,, ,, 21 10 P. M. Queen depositing eggs.

stock will not swarm: (of course we are now speaking of a stock of bees in a common straw hive, having no means of affording extra room for the increased number of bees. Yet even in a stock of bees, where ample means are at hand for affording working room, the bees will occasionally use the extra space for this lying out, as it is termed, instead of using it as a storehouse for honey). What then is the explanation of all this? We may occasionally, when a hive is in this state, see the bees which are lying out drenched with rain; yet there they still pertinaciously hang. Why then will not the bees remedy the inconvenience by forming an independent colony? simply because they have no queen in a proper stage to lead them forth. The old queen has died a natural death, leaving young queens in various stages of forwardness, and until one is matured the swarm cannot go forth; the time for this perfection of the queen has been passed in the listless idle state we have been describing, and by the time the young queen is matured, particularly if unfavourable weather should ensue, the season will be so far advanced that the stock will not swarm. Here then is the secret of the stock not swarming, the renewing of the queen is the cause of all; the queen existing in the year 1852 in the stock we marked C has been the leader of swarm after swarm, has successively reigned in the hives A, B and C, has left her home time after time until nature has become exhausted and she has died full of years, and her successor reigns in her stead.

That this change of queens takes place in the summer after the hatching of drones, or at all events after the laying of drone eggs, is very evident; for were it not so the young queens would be barren for the want of the drones to impregnate them, and the inevitable loss of the stock would be the consequence.

It does not invariably happen that the change of queens is always preceded by the hanging out of the bees, that will depend in a great measure on the numerical strength of the stock, and the amount of space provided for them in the hive; but still the stock, though strong enough to swarm, will not do so, and when the great inconvenience and danger to the bees in hanging out is taken into consideration, it strengthens the argument that some dire necessity compels them to endure the inconvenience and risk the danger. Again, the renewal of the queen may take place without any other symptom being present than the nonswarming of the stock; the honey gathering may not be interrupted in any degree, nor the ordinary labours of the hive suspended.

This renewal of queens, it may particularly be observed, is in every respect analogous to the natural state of a hive in swarming, with only one exception; viz. that the old queen, instead of going off with the swarm, dies. The state of the hive at the period of the death of the queen in the one case, and the departure of the swarm in the other, is exactly the same: in both cases drones and drone brood exist in the hive, young queens are in embryo ready to come forth in a few days, and worker bees and worker grubs are to be found in abundance; the stock in both cases is thereafter left to the government of the young queen, and with the solitary exception of the departure of the queen with a portion of the population, the two instances of swarming and renewal of the queen are exactly similar: to the stock therefore at the end of the season the result is the same.

Much difference of opinion has existed whether the swarm is led by the old queen or a young one, and in support of the view that the swarm is led by a young queen, the analogy of the swarming of ants has been sometimes alluded to, where undoubtedly the young queen leads; but the queen ant, immediately her colony is settled, casts aside her wings, as no longer needed, thereby utterly preventing herself from ever afterwards leading a swarm. The queen bee does not do so, and therefore the analogy no longer exists; but, on the contrary, it may be contended that the queen bee retains her wings expressly for the necessity of leading the swarm.

It may here be observed, that if the view taken above as to the renewal of queens is correct, when a stock of bees throws off its swarm late in the season, and after such renewal (but which will rarely happen), strictly speaking it is not a swarm, but only a cast: a swarm, properly so called, is led by the old queen capable of producing eggs of all kinds,—queens, workers, and drones, whilst the queen leading the swarm thrown off under the circumstances just detailed is a young queen, and will produce in that season only worker eggs. That the queen leading a swarm is capable of producing queen eggs, is at once evident from the fact, that such swarm in favourable seasons will throw off a *maiden swarm*, and of course under such circumstances drone eggs must also have been produced, or the young queens left in the hive at the departure of the maiden swarm would be barren, and the loss of the stock ensue. In the case of a maiden swarm the old queen will have changed her habitation twice in the same season; whether this double swarming has any effect on the duration of her life future observation must prove.

Several singular facts should be here noticed with reference to the proceedings of a cast, viz. that in the comb built by a cast in its first season, all the cells are of the small size used for rearing worker bees; no drone cells are built; the hive or box, unless very small, will not be filled with comb, and the space left unoccupied will be found to be that usually the position of the drone cells. It has occurred to our recollection in the preparation of this essay, that occasionally a hive stocked with a *late swarm* has been found not filled with comb, but the observation was not carried to the extent of noticing whether drone cells were absent; if such should hereafter be found to be the fact, that drone cells are wanting in the comb built by a *late swarm*, it will be a complete confirmation of the theory, that such late swarm was in fact only a cast, led by a young queen, and a complete proof likewise that a renewal of queens had taken place.

A cast, it will be seen, can never throw off a swarm in the first year of its existence, for the simple reason, that *only worker bees** are produced, and no drones or queens are produced until the spring succeeding its establishment as a stock.

The winter of the year 1851, and spring of the year 1852, was singularly fatal to the stocks of bees in the immediate neighbourhood of the writer of this essay, and a post-mortem examination with some certainty points to the death of the queens as the cause of the loss of the stocks. An opportunity was embraced of examining six of such stocks; scarcely a single bee was found in any one of the hives, and no trace whatever of the queen was visible; each hive was well stored with honey, so that starvation was not the cause of death; the hives were dry, and the bees had been apparently healthy, but they had in each case dwindled away, or had gradually deserted the hives. Four of these stocks had swarmed in the summer of 1851, so that the queens would be young ones; two of the stocks were alive as late as February, 1852, but there was no trace of breeding in the combs: what, then, was the cause of death in these instances? In the four stocks which had swarmed barrenness of the young queen might be suggested, but in the two stocks which had not swarmed such could not be the case. From a careful examination and consideration of these appearances, and the attendant circumstances, it must be admitted that the death of the queen was the source of all the mischief, but what was the real cause of her death is a mystery not so easily cleared up.

* Having stocked my observatory hive this year with a cast I can speak to this fact.

As a contrast to the fatality amongst queen bees just noticed, we have made the following extract from the Note Book mentioned in this essay at page 146, and as an instance of the extraordinary number of queens produced from three of the stocks in an apiary of six, during that year (1847); and it is remarkable that in the same apiary, comprised of the same number of stocks, not one queen bee was killed in the year 1852, not a single swarm having issued from any one of the stocks in the apiary.

That the season must have considerable influence in the production of queens must be self-evident, otherwise why should stocks of bees in 1847 produce an over abundance of queens, and in 1852, under precisely the same management, produce none? Had only one stock omitted to throw off a swarm, it would be assuming too much to attribute the omission to the season, but when the influence extends to all the stocks in an apiary, and to great numbers of stocks in the immediate neighbourhood, the cause may then fairly be attributed to the peculiar season. Two of the stocks now living (1852) are the identical stocks mentioned in the Note Book of 1847, numbers 2 and 4, one of them having been hived in 1845, and the other in 1846.

“ *YEAR 1847—Stock No. 2.*

- “ June 12. Swarmed; deprived the swarm of the queen, and returned them.
- „ 20. Cast; caught two queens; returned.
- „ 25. Came out again, and joined bees from Nos. 3 and 4.
- „ 26. They set to work well.

“ *Stock No. 3.*

- “ June 5. Saw appearance of swarming after they had worked comb in a glass on the top of the hive; a queen's cell visible.
- „ 6. Inverted the hive, hoping to destroy young queen thereby.
- „ 12. Swarmed; deprived them of the queen, and returned the swarm.
- „ 20. Cast, and I caught queen on the alighting board before she took wing.
- „ 23. Cast again, and I caught queen again in the same manner.
- „ 25. Came out again, and joined bees from Nos. 2 and 4
This stock died in March, 1848.

" Stock No. 4.

- " June 8. Heard piping, but never saw swarm rise, and never missed the bees as to numbers, either from the stock hive or glasses.
- „ 10. Found young queen dead on alighting board.
- „ 11. A swarm or cast issued ; caught queen, and returned the bees.
- „ 15. Came out again, and I killed queen as she was coming out of the hive.
- „ 19. Came out again, and I killed two queens after they had settled ; returned them.
- „ 20. Caught another queen on alighting board.
- „ 22. Came out again ; deprived them of queen, and returned them.
- „ 25. Came out again, and joined bees from Nos. 2 and 3. The bees from 2, 3 and 4 having all joined in one lump on swarming, I took them in two common straw hives ; I afterwards dashed them all out on a white cloth, picked out three queens, and then distributed the bees amongst each of the hives 2, 3 and 4, and they all afterwards worked well. No. 4 produced 40 lbs. of honey in glass."

In the preparation of the portion of this essay treating of the age of the queen, the actual pedigree of a stock in the writer's apiary is stated ; but upon making up, from the notes previously mentioned, the pedigree of other stocks, the period of the change of queens, evinced by nonswarming, was found not uniformly to correspond with the three years. In several cases the time was found to be four years, and in only one instance two years (the notes in the latter case were rather imperfect, in consequence of the stock having swarmed whilst the writer was absent from home, and it is not deemed safe to depend upon them) ; and although it may be deemed too presumptuous to assert that the age of the queen bee is in reality three or four years, yet the facts adduced above from personal observation, and the deductions and conclusions drawn therefrom, will be deemed a sufficient apology by the writer in thus stating his belief that his opinion is correct.

Before concluding this portion of our subject treating of the age of the queen, we may merely notice the experiments of Huber the naturalist, detailing the production of a queen bee from worker eggs ; but as this renewal of a queen cannot be considered as a natural, but rather as an artificial one, it does not strictly fall

within the province of the present essay, and the only point in which such experiment can assist us, would be to fix the date of birth of the queen bee, a date which can be as accurately fixed without the aid and risk of the experiment. So much doubt also has been thrown upon the existence of the power of the worker bees thus to create a queen, that we felt any argument, founded upon the production of a queen in the mode detailed by Huber, would be open to the same doubts as Huber's experiments. The question as to the power of the worker bees to produce drones is still entirely an open one, and it would seem that the reproduction of a queen bee alone from worker eggs, before the period at which the drone eggs are to be found in the hive, would only prolong the misery of the stock, ultimately to die from the barrenness of the queen; for without drones how could the young queen so produced become fertile? and unless the worker bees also possess the power of rearing drones from worker eggs, the mischief arising from the loss of a queen at those particular seasons when only worker eggs are to be found in the hive would inevitably be fatal. It would therefore be exceedingly important if the attention of apiarians was drawn particularly to this subject, that experiments might be instituted to prove the fact.

The writer of this essay is free to confess, that he was a sceptic regarding the production of a queen bee from worker brood, even up to the time of some portion of this essay having been written, but an apiarian friend having two dead stocks not broken up in his apiary, which had died in the winter of 1851, gave them to the writer for examination, and in one (a stock of at least ten years old or more) he found, and has preserved, a most unique specimen of a queen cell in the midst of worker cells, wherein evidently a plebeian queen had been reared; this, of course, at once settles the matter in his mind.

AGE OF THE DRONE.

In entering upon this part of our subject we do not labour under so many difficulties, in collecting materials to form our conclusion as to the duration of life in this insect, as we do with respect to the queen bee. When drones are existing in a hive they are daily coming forth for an aerial trip, should the weather permit; and in every hive, whatever may be its construction, if it is in any way provided with a glass window, the drones may invariably be observed; still, however, the difficulty of individual identity exists.

Drones, or male bees, are not found in the hive at the time the queen commences laying eggs in the spring. Every one had been unmercifully killed or disabled, and expelled from the hive, in the

preceding autumn by the worker bees; we can therefore date the birth of drones with accuracy. The drones generally make their appearance in May, in stocks unusually strong; they may occasionally, but rarely, be seen in April, and drone brood may be found in hives so late as August; and it is not uncommon to see drone grubs and the pupa in various stages brought out from the hives at the time the annual massacre of the matured drones takes place; total extermination of that class being evidently the object of the workers.

The ordinary limit to the life of the male bee may thus with certainty be embraced in the period extending from April to September, but that period is only the one *allowed* to the drones by the worker bees, and the natural life of the drone may be considered more the object of inquiry in the present essay than the period during which the drones are permitted to live.

That the drones would exist for a longer period if the workers did not destroy them, is evinced by the fact, that in a hive when by any accident the queen is not impregnated (and this more frequently happens to a cast), the drones still remain in the hive long after the month of September; but the very circumstance of their remaining in the hive unfortunately deprives us of the means of noting the duration of life in the drone, because the stock being in an unnatural state from the barrenness of the queen, dwindles away and dies, drones as well as workers, generally about the month of December, or it may be January, and this closes the scene of our observations; whilst were we to remedy the evil by furnishing the stock with a fertile queen, an immediate slaughter of the drones would take place. It may here be observed, that it is not always permitted to the drones to exist so late as July or August, but occasionally in a very populous colony the drones are killed and turned out of the hive in May or in the early part of June, and frequently, though not invariably, a second destruction of drones takes place at the usual period; this double destruction of drones has not yet, as we are aware, been satisfactorily explained, but one fact may be recorded which may assist in solving the mystery—that when an early slaughter of the drones takes place, the stock of bees *will not swarm* that season.

Having thus seen, that under all circumstances whilst the hive is in a natural state, the existence of drones is a merely permissive one on the part of the worker bees, and that whenever the state of the stock is such as to cause the workers to permit the drones to live, they exist as long as the workers themselves; we

shall not be assuming too much in concluding, that the natural duration of life in the drone is the same as in the worker bee.

AGE OF THE WORKER BEE.

Here again we are beset with the difficulty of individual identification, and the worker bees are so numerous that any marking of the whole number existing at any one period in a hive is almost out of the question. The marking of a portion would not help us in any great degree; indeed, were a worker bee to be marked by any substance being attached to its body, or by a dot of varnish, paint, or any thing of that kind, in all probability it would lead to its untimely end in one shape or another, so that an experiment of that kind could not be depended upon; and were the marking not to be of a permanent character, the extreme cleanly habits of the bee would speedily lead to the obliteration of the mark. We cannot therefore obtain assistance in our research by any mechanical means of this nature.

Worker bees exist in the hive or stock at all seasons of the year; but whether they are the same bees is the question more particularly now to be discussed.

Let us enter into a calculation as to the number of bees produced in a hive at various periods of the year; and this though seemingly impossible, when reduced to a system is rendered simple, and the result accurate. It is a well-known fact, that in the month of January, from some cause or another, whether natural or otherwise will hereafter be seen, the worker bees are reduced to a comparatively small number, though that month is not always the time when the smallest number of bees are present in the hive. This number must be estimated, and it will be the only quantity which cannot be determined by actual calculation. It is true we might by fumigation determine the real number; but such a proceeding at this period of the year would very likely lead to the death of the stock. We may safely take the number in a fair stock at from 6000 to 8000; on fumigation the stock would be found to contain about three pints of bees; and as 2000 bees are contained in a pint, this estimate of 6000 is as nearly accurate as possible.

Breeding commences in the month of January, and we should find on examination that the space of comb occupied by brood at that season will be about six inches in width and four inches in depth, giving a superficial surface of twenty-four square inches.

Now brood is always present on opposite sides of the same comb in the regular seat of breeding in a hive (in glasses and at the sides of the hive in the heat of summer this is not uniformly the case) ; we therefore multiply the twenty-four by two, giving forty-eight square inches of brood in January.

If a piece of brood comb containing worker cells be measured, it will be found that on an average twenty-seven cells are contained in a square inch;* thus we have 1296 cells containing brood in the month of January. In February this breeding surface will have been extended to three combs, the centre one having a larger surface occupied than in the preceding month, and the comb on each side of the centre one having about the same quantity in February as the centre one had in January. This gradual progression extends until the month of June, when the greatest number of cells will be found to be occupied with brood.

Subjoined is a table showing the number of combs used in each month for breeding purposes, the number of cells in each comb, and therefore the number of bees reared during the eight months from January to August inclusive. The actual time required for a worker bee to arrive at maturity is twenty-one days. In the table we have calculated each cell to produce one bee during the month ; but in fact there is an excess of nine or ten days in each month. This may be allowed for the cells which are occasionally missed by the queen in depositing eggs,—for inequalities in the shape of the space occupied by brood comb (our calculation of space in each case being a regular parallelogram),—for the time which elapses between the young bee emerging from the cell and its being again used,—and for the interregnum occurring between the time of the departure of the old queen with the swarm, and the establishment of the young queen in the monarchy of the hive, during which period no eggs are laid. These deductions for all practical purposes will render the calculation of one bee per cell per month as nearly accurate in its result as possible. We have presumed that the stock forming the subject of our calculation in the table swarms in the middle of June ; if it does not swarm, the number of cells occupied with brood in July will

* A piece of comb 4 inches square will be found to contain 22 rows of cells of $19\frac{1}{2}$ cells in each row. A piece 3 inches square will contain 17 rows of $14\frac{1}{2}$ in each row. The average of the calculation on these data will give 27 cells to the square inch as nearly as possible.

somewhat exceed the number stated in the table; in other respects it will not differ.*

Month.	Number and Disposition of Combs occupied by Brood, each Comb having two Surfaces in use.	Space occupied in each Comb, expressed in Inches.		Superficial Area of the two Sides of each Comb in Square Inches.	Total Breeding Surface of each Month.	Total Quantity of Bees hatched in each Month.
		Width.	Depth.			
JANUARY ..	One	6	4	48	48	1,296
FEBRUARY {	One	4	4	32	112	3,024
	One	6	4	48		
	One	4	4	32		
	One	6	4	48		
MARCH .. {	One	8	6	96	192	5,184
	One	6	4	48		
	One	8	6	96		
APRIL.... {	One	8	6	96	288	7,776
	One	8	6	96		
	One	6	4	48		
MAY {	One	8	6	96	384	10,368
	One	8	6	96		
	One	8	6	96		
	One	6	4	48		
	One	8	6	96		
JUNE {	One	8	6	96	480	12,960
	One	8	6	96		
	One	8	6	96		
	One	8	6	96		
JULY {	One	8	6	96	288	7,776
	One	8	6	96		
	One	8	6	96		
AUGUST .. {	One	8	6	96	192	5,184
	One	8	6	96		
Total ..						53,568

Taking this table as our guide, we shall find that the number of bees bred from January to the middle of June (the usual period of swarming in the district of the writer of this essay) amounts to 34,128; add to this the 6000 bees existing in January,† and we

* In this table the centre comb of those bracketed together in each month is supposed to represent the centre comb of the hive, and the disposition of the other combs will also be as in the table.

† This addition is for the purpose of calculating the total number of bees dying; we shall hereafter see that not one of these bees was alive at this time.

have 40,128 as the population in the middle of June. Let the stock now throw off a swarm of 20,000 bees; this reduces the number to 20,128. We now add the remainder of the bees bred in the month of June, which raises our number to 26,608; let a cast now be thrown off, which sometimes will nearly equal in bulk the swarm—take the quantity of bees at 12,000—which reduces our population to 14,608. We now add the bees produced in July and August, bringing our numbers up again to 27,568, as the total quantity of bees existing in the hive on the 1st September. Breeding may be prolonged a short time subsequently to this date; but the number produced is small, and of no importance to the discussion of our subject.

Now every observant apiarian will be aware that on the 1st September in any season, he will not have 27,568 bees existing in a stock, even if it happens to be exceedingly strong and has not swarmed; but according to our calculation that number ought to be existing, and forming the population of the hive. We must, therefore inquire how and to what amount their numbers have been reduced. The answer is, partly by accident, partly by enemies, such as birds, spiders, &c., and partly by natural death, the numbers have been brought down to something like 12,000; so that by taking the census of the original stock, we find a loss, and we have to account for the disappearance of 15,568 bees in the course of eight months.

It cannot, it is true, be said that all these bees die a natural death; the enemies and casualties to which the worker bees are exposed are so numerous, that the deaths arising from these causes must evidently form a large proportion; but at the same time it must be conceded that natural death has been the great agent at work to cause the disappearance of so large a number as 15,568 from one stock in so short a time, and we shall therefore be justified in assigning the limit to the duration of life in the worker bee to the period answering to the general result of our calculation.

Now if we add the 32,000 bees which departed with the swarm and cast from the hive, we have a total of 47,568, and we find that this number will absorb all the bees produced in the hive to the end of June and a few days further, and including therein the 6,000 bees existing on the 1st January;* it follows, therefore,

* Bees produced to the end of the month of June, see table, p. 159 ..	40,608
Bees existing in January	6,000
	<hr/>
	46,608
	<hr/>

that no bee living in the hive on the 1st January can have survived later than the 1st September, except it is existing either in the swarm or the cast; this, therefore, fixes the maximum duration of life in the worker bee at eight months at this period of the year (we use the expression "at this period of the year," because we shall presently see that the duration of life in the worker bee is not uniform).

Let us further examine how far our figures carry us out in the remainder of the year. On reference again to our table, we shall find that 12,960 bees are produced subsequently to the 1st July; and as it would seem from our last calculation that all the bees produced previously to the 1st July are absorbed in the number missing on the 1st September, it follows that these 12,960 bees will form the population with which our stock is to brave the dangers of the winter season, and from natural death and other causes it will even be reduced to 6,000 or 8,000 by the succeeding January, thus bringing us again to our starting point: taking eight months as the maximum of the life of the worker bee, the whole of these 12,960 bees will die by the 1st May, and as a large proportion of these bees will be eight months old on the 1st April, previously to which time but a small number of bees will have been produced to supply their loss, the month of March may well be termed a critical period for a stock of bees, simply for the reason that if the breeding has not been carried on with sufficient vigour to replace the bees dying off at this time of the year, so great a diminution in the number will take place that the stock will be in danger of death on that account; and even if it survive it will not be until the weather becomes mild and genial in May and June, that the stock will be able in any way to recruit its strength. Loss of stocks at this season of the year need not therefore surprise us.

Although we have demonstrated that the life of the worker bee does not exceed eight months, yet we have not shown that it reaches that period; and although we can assert as a fact, that of the 6,000 bees existing on the 1st January all were dead on the 1st September, yet we have not ascertained the time of their deaths, and as those bees were some of them six and some four months old when we commenced our investigation (having been produced between the 1st July and the 1st September in the preceding year), we must inquire when they die, in order to state their age. Now we find that 4,320 bees are produced in the months of January and February, and as a matter of course these young bees will form a great proportion of the population

of the hive at that season, yet the population will exceed that number, consequently some of the bees in the hive on the 1st September in the previous year must be still alive; if we repeat this calculation on the 1st April we shall again find (making allowance for the loss of some of the bees produced since January by accidents, enemies, &c.) that the population again exceeds the number of young bees, thus showing that some of the 6,000 bees have still survived. If we take the census of the hive on the 1st May, we shall find that 17,280 bees have been bred since the 1st January, and this number (even after deducting for losses by enemies, bees lost in the showers of April and other causes) will exceed the whole population of the hive at that period; consequently we arrive at the fact that all the bees living on the 1st September in the previous year are dead prior to the 1st May in the next year, thus confirming our previous calculation that eight months is the maximum period of life; and we have also seen that, though all the bees are dead at the end of eight months, yet that some have lived longer than seven months.

The portion of the year comprised between the 1st September in one year, and the 1st May in the succeeding year, being that in which the life of the bee is passed in the most quiet state, in the depth of winter even approaching torpidity, and consequently the wear and tear of the muscular as well as the nervous system of the insect is least, it is fair to suppose that the duration of life is the longest, and that therefore eight months is in truth the maximum duration of life in the worker bee.

We ought now to inquire into the minimum duration of life:— we have plainly shown that all the bees produced previously to the 1st of July are dead or gone by the 1st September, a period of two months; and as this is the season when the vigour of the worker bee is called into the greatest activity, when the muscular system of the insect is taxed to the utmost, when the nervous system is subject to the greatest excitement, and when in fact night or day there is scarcely a moment's rest, it is reasonable to assert that the frame of the insect is sooner worn out, and therefore that the duration of life is shortened to the minimum period of two months. It will as a natural result follow, that the limit of life will vary from two to eight months, according as the powers of the insect have been taxed, so that those bees produced in January may survive six months, February a shorter period, March a shorter period still, down to the minimum of two months.

The non-uniformity in the duration of life in the honey bee is not a singular instance in Entomology; in all double brooded

insects the duration of life in the same species at different periods of the year is unequal;* and when a palpable reason can be adduced why the frame of an insect should be sooner worn out at one period of the year than another, it will be a justification to our assigning a shorter period to the life of the worker bee at that particular season, more especially when the various calculations we have followed out lead us to the same result; and we may remark, that some months of the winter season, the period of the longest duration of life in the bee, is passed in a state of quiescence nearly approaching that of the chrysalis of the double brooded insects.

We must now turn our attention to the 20,000 bees composing the swarm thrown off in the middle of June, and follow up the calculation with respect to them. Now these bees we have heretofore seen were all young bees of that year, as we proved that none of the 6,000 bees existing in January had lived beyond the 1st May, and the swarm does not depart until June.

On the 1st September we shall find that the population of this swarm does not reach 20,000, nor nearly so; we shall also find that the old queen, after establishing this new stock, will have produced above 12,000 brood, and as this number (12,000) does not exceed the actual population of the hive at the period of which we are now speaking, it follows that the whole number of bees leaving the stock hive as a swarm have died, and their place supplied with young bees.

If the same test is applied to the cast, the same result will follow, so that this is confirmatory of our assertion in the former part of this essay, that all the bees produced previously to the 1st July have died prior to the 1st September.

We are now able to appreciate the advantage possessed by a stock of bees which has not swarmed, in point of working numbers, over one which has swarmed.

The loss sustained by the hive swarming is that of 20,000 bees ready for work, and ready to take advantage of the season in gathering and storing honey. If these bees were to remain, and the season proves favourable, the whole of the honey gathered by them will be surplus store, and will amount to a large quantity; if they depart as a swarm, but just sufficient bees are left to carry on the ordinary operations of the hive, no surplus honey store will be produced. The departure of a swarm, therefore, is a serious loss in an economical point of view to the stock from

* The swallow-tailed butterfly is a familiar example.

which it departs, and to the bee keeper it entirely destroys his prospect of obtaining honey from the stock, except he is bent upon its total destruction to obtain the little store they have, Surplus honey, unless the swarm rises very early in the year, and the season is very favourable, is quite out of the question.

It may appear strange, yet it is not more strange than true, that the 20,000 bees composing the swarm, after toiling to increase the store, do not help to consume it, but die, leaving the produce of their labours to support the life of their successors for the long period which is to elapse before the store can be replenished. What provision, then, is made to obviate the danger of absolute loss of the stock, whether in the hive or in the swarm, from the death of the 20,000 bees? We answer, if the parent hive has not swarmed, the numbers are kept up from eggs laid by the old queen; if it has swarmed, the numbers in the swarm are kept up by the old queen, and in the parent stock her place is supplied by a young queen, who, although she does not immediately commence laying eggs on the departure of the swarm, yet does so sufficiently early to produce brood to replenish the stock, so as to withstand the vicissitudes of the winter.*

This brings us to consider whether a double swarm, or, more properly speaking, the bees of two swarms joining in one, is advantageous or not. When a number of hives are kept near each other, two swarms, and sometimes three, will settle together; and although it may at first sight appear extremely advantageous to have so large a quantity of bees in a swarm, yet, when we reflect upon the fact that the whole number, large though it be, will die previously to the autumn, we must concede that the advantage in point of numbers continues for only that one season. It is true the vast number of matured workers will be enabled more speedily to build the necessary combs to establish the swarm, and the apiarian may without risk give the swarm extra space for surplus honey, whereby he may reap a present profit by taking honey from a swarm the first season; whereas, had it not been a double swarm, it would scarcely have been possible to do so without the risk of impoverishing the hive. Here the advantage ends, for notwithstanding two queens would rise with the double swarm, only one would be allowed to live; and the number of bees produced in the hive by the queen governing this double swarm,

* 1852 Aug. 5 Counted 4,090 cells of brood sealed over in observatory hive.

N. B. These same cells, to the extent of about two-thirds, were afterwards occupied by a second batch.

„ Aug. 19 Second course of brood beginning to be sealed over.

would not be larger than if she were the monarch of only a single swarm; in the autumn the population would not be greater, and therefore the benefit ceases with that season. Far greater advantages result from the union of stocks in the autumn, a subject we shall notice in a subsequent part of this essay.

We conclude this portion of our essay with one more observation respecting swarming, viz., that at the time a swarm is thrown off, the greatest number of cells are occupied by brood, and by the time they are hatched off, a young queen will be ready to deposit eggs and continue the breeding, so that swarming does not in any great degree alter the total numbers actually produced in a stock during the year, whether it swarms or not: the young queen, though she does not begin to lay eggs immediately on the departure of a swarm, continues to lay later in the season than the old queen, so that the brood produced is thereabouts equal in both cases: the reduction in the number of matured workers by the emigration of the swarm and cast is nevertheless a serious consideration with respect to the quantity of surplus honey which may be expected from the stock.

Having successively treated of the age or duration of life of the queen, drone and worker bee, and having pursued at length the arguments supporting our views on the subject, at the same time noticing the observations on which our arguments are grounded, we now proceed to the consideration of the practical question, whether it is more expedient to retain swarms when it may be necessary to reduce the number of hives in an apiary, and destroy old stocks, or vice versâ.

In speaking of stocks, we must be understood to include hives in their second season, and upwards.

It must be obvious that we are in a great measure prepared to enter upon the discussion of this subject from the consideration of the various circumstances brought to bear in elucidating the duration of life in the bee, more especially that of the queen bee; and notwithstanding the strength of a stock of bees may be greatly dependant upon the number of workers, yet the future well-being of the stock must mainly be owing to the age, health and fecundity of the queen, and in this latter particular the queen is again dependant upon numbers, in order as it were to bring into play her extraordinary multiplying powers: the state of the queen therefore must particularly be considered in coming to a decision on this point.

We have seen that in respect to population, the difference between a swarm and a stock at the usual period of taking up hives

is pretty nearly the same, and that the number of young bees in each case will also be nearly the same, so far therefore the balance is equal; but there are many other circumstances tending to show that the first winter of a swarm is a critical period, and on that account, it is preferable to retain stocks of one year old or upwards, instead of swarms, when it is *absolutely necessary* to reduce the number of hives in an apiary.

We now set forth the advantages possessed by stocks, and the disadvantages attending swarms, in parallel columns.

Disadvantages attending the retention of Swarms.

The hive peopled by a swarm may very probably not be entirely filled with comb; if so, the open space will render it much more cold and uncomfortable than if the whole interior were filled with comb, and the bees will be more liable to be chilled when they begin to traverse the comb in the spring.

A swarm may in truth have a greater weight of honey than a stock, yet it may not have a sufficient quantity of pollen, or bee bread to consume, before the advance of the spring will enable the supply to be renewed.

The queen will certainly be one year old; she may be two, and even three, and therefore so much nearer the time of her natural death, rendering the hive liable in a succeeding year or two, to the danger and risk attending her renewal; and being an old queen, she does not continue the breeding so

Comparative advantages possessed by a Stock.

In the second season, when the swarm becomes a stock, the hive will be filled entirely with comb.

A stock will always be plentifully supplied with pollen, and generally with honey: although it sometimes occurs, it seldom happens, that an old stock dies of actual starvation.

The old queen having departed with the swarm, the queen now governing will be a young queen of that year, and this most important advantage is possessed by the stock in consequence, viz., that the breeding by the young queen being carried on later in the season than by an old one, and

Disadvantages attending the retention of Swarms.

late in the season as a young one.*

Comparative advantages possessed by a Stock.

let us suppose that even 500 or 1000 bees are produced after the 1st of September, their thread of life will not be run out so early in the succeeding spring, and it must be apparent that the aid and assistance of these 500 or 1000 bees for a fortnight or three weeks, at the critical time pointed out in our discussion of the age of the worker bee, will be of paramount importance in ensuring the future strength of the stock, as it is almost a maxim in bee economy, that a strong hive at that particular time will become stronger, whilst a weak one will become weaker.

Against the advantages thus possessed by a stock over a swarm, we must not lose sight of the disadvantage in a stock arising from the cells having become so contracted with the cocoons left by the bees after continuous breeding, as to be rendered unfit for use; but as this will only happen in a stock much advanced in years (more than five or six), the preponderating advantages possessed by a stock of two or three years over a swarm are so great that we may safely conclude to give the most earnest advice to select stocks for stores instead of swarms; even the single disadvantage attached to a stock, alluded to above, may be obviated, if the hive is so constructed as to allow the combs being readily cut out at the proper season of the year, to enable the bees to renew them.

We have already seen that a double swarm is in reality not of much permanent service to the apiarian, but a few moments' reflection will convince us that the case is very different with the autumnal union of the bees then composing stocks or swarms;

* In the observatory hive the young queen was laying eggs in the second week in September, though very slowly.

and as we admit occasionally an absolute necessity may occur for reducing the number of stocks (the idea of *murdering* the bees ought to be completely banished from the mind of the apiarian), and when reasons can be shown why a union is really an advantage, it is hoped that the brimstone match may speedily become a mere matter of history. Referring therefore to the portion of our essay treating on the worker bee, we may perceive that if the union is delayed until after the 1st September, or it would be safer to say until towards the end of that month, all the bees then in the hive would be bees which would survive the winter; and if the bees of the swarm are added to those of the stock it will have the effect of doubling the population of the hive during the whole of the winter season. The consequence will be, that the increased heat of the hive will sooner induce the queen to deposit eggs; and a perusal of the preceding pages of this essay will carry conviction as to the benefit a stock of bees will receive from the renewal of the population of the hive being commenced earlier, or carried on with more vigour in the spring of the year than under ordinary circumstances: if instead of 3024 bees being produced in February, 5000 were produced, and a corresponding increase were also to take place in the numbers produced in the succeeding months until the time of swarming, the advantages must be palpable, and all owing to the surplus population obtained from autumnal union of stocks and swarms.

In thus as it were parading the advantages of autumnal union, we must not be understood to advocate the system generally, but only that it may be practised in cases of necessity. The operation of fumigation necessary to complete the union is a very delicate one, and requires to be performed with extraordinary care to be successful; in the practice of it we have found nothing to interfere with the operation so much as the sticks usually placed across the ordinary straw hives by cottagers; these sticks create so much difficulty in extracting the combs, that we have several times declined to operate for our friends solely on that account, being desirous that we should not personally be blamed for the failure of an experiment arising from impediments which we could not remove.

By a little management and foresight the union of stocks and swarms, we will not say *destruction*, may be prevented; and as prevention is better than cure, we will, even at the risk of being charged with prolonging the essay to an immoderate length, devote a few lines to this important question. In the swarming season let the apiarian consider well and determine his intentions

and wishes respecting the future number of his stocks. In case he does not wish to increase the number of his stocks, when a swarm rises let it be returned; then let him watch carefully the proceedings of the hive or stock for the next nine or ten days. If young queens are brought out dead, exceeding three or four, he may be quite certain the stock will not cast; if the stock commences honey gathering with energy he may also rest satisfied that it will not cast. Should however the bees be determined to follow their natural course, and cast, they must be returned again and again until the whole of the young queens are disposed of, when the stock will quietly settle down, and the apiarian may look forward to his honey harvest. He will by this means have the increase of his stocks entirely at command; he will have the benefit of the labours of his surplus population; and if quality and fineness of honey is his aim, he can by no other means secure his object so certainly and safely as by returning his swarms, because in a stock when the swarm has been returned, no fear need be entertained of the queen depositing eggs in the glasses or boxes intended for surplus honey, and therefore extreme purity of the honey as well as whiteness of the comb it attained.

This process of returning is an exceedingly simple one, and certain of success: the bees are hived in an ordinary straw hive, and when they are settled (probably about twenty minutes after being taken), they should be dashed out on a white cloth by suddenly striking the hive mouth downwards on the cloth—the sharper the stroke the better; the hive should immediately be lifted up, and the bees will be seen in a confused lump on the cloth; *they will not rise or take wing*, but will spread themselves on the cloth. The queen must now be watched for diligently; when seen, she should be covered with a wine-glass, then slip under the glass a card or a piece of zinc, and care taken that she does not escape: she must be removed and killed. The bees may then be left to themselves, and they will, when they miss the queen, take wing and return to the stock whence they issued; but what is better, the cloth may be taken up by the corners, laid on a board sloping towards the mouth of the hive, and a communication made between the bees of the swarm and the stock: as soon as this is done, the bees of the swarm will be as anxious to return as they were to come out of the hive, and the operation will be complete in less than half an hour.

There is no danger in the operation whatever; we have performed it scores of times without covering of any kind, and with-

out being once stung in completing it, and we are quite sure that any apiarian who has once seen the experiment carried out, and has noted the advantage to be derived therefrom, will be certain to adopt it. Plain practical directions may be given for performing the operation, but our strong advice to every one is, not to omit seeing it done by an experienced apiarian, if possible; more may be learned and more confidence gained in seeing once, than in reading a dozen times. We have practised this system entirely for the last six years, and during that time have never had occasion once to resort to any expedient to reduce the stocks in our apiary: the extract from "my note book," of the year 1847, given at pp. 153 and 154, will show how far the increase of stocks was prevented in that year; from the number of queens killed, the probability is, that had not the system been persevered in, the stock No. 4 would have been split up into numerous colonies, and forty pounds of *honey in glass* would certainly not then have been obtained.

We cannot better conclude this essay than by suggesting an experiment which occurred to us in the year 1851, but from the extraordinary circumstance of our not having a single swarm in our apiary in 1852 it was impossible for us to carry out; and in thus making it known, we may probably induce some of our apiarian friends to try the plan, and thereby it may the sooner be established as successful, or not, and the benefit, if successful, may be the sooner promulgated; in doing this, we feel we are not overstepping the bounds of this essay, inasmuch as the experiment bears practically on the prevention of the increase of stocks. In the year 1851, by accident, the bees of a swarm were returned to a hive to which they did not originally belong; that hive had been previously not much inclined to work (it is true, the population was not over large); immediately the bees of the swarm had joined this hive, the whole population commenced working vigorously, and produced in the season a fair proportion of honey; the stock from whence the swarm issued was a strong one, and although it did not produce as much honey as it would have done had the bees of the swarm been returned to it, yet it gathered strength and produced three glasses of honey, one being thirteen pounds in weight.

Now it occurred to us, that as the accession of the quantity of strange bees to the lazy hive immediately induced work, that it would be prudent, instead of returning the bees of a swarm to the stock from whence the swarm issued, to join them to another

hive (if the queen be taken away, any hive will readily receive them); and the next swarm which issued from any other hive might be joined to the first hive which had thus lost its swarm, and so on, keeping up a continuous change of the quarters of the bees when they swarm.

We have always observed, that, after returning a swarm to the stock to which it originally belonged, such stock does not generally set to work steadily until after the lapse of four or five days; and we argue the reason to be this,—when the bees are returned, they find their own hive in precisely the same state as when they left it, and there is therefore no inducement to work, in fact the bees are disappointed; but if these bees are joined to a hive where a different state of things exists, then that they are instigated to pursue their natural labours and gather honey. This is merely the idea of the writer; but the accidental experiment having succeeded so well, he has ventured to mention it, at the same time explaining that he has not yet had the opportunity of testing its invariable success.
